MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

ETN2046 – FUNDAMENTAL OF WIRELESS COMMUNICATIONS

(TE)

3 JULY 2023
09:00 a.m. – 11:00 a.m.
(2 Hours)

INSTRUCTION TO STUDENT

1. This examination paper consists of **8 pages** (including the cover page) with **4 questions only**.

2. Total marks for each question is **25 marks. Attempt ALL parts of the questions.**

3. Please write all your answers in the Answer Booklet provided. **Show all relevant steps** to obtain maximum marks.

4. There is an **appendix** of useful constants and formulae at the end of this question paper.

Question 1

(a) Wireless communication does not require a physical medium but propagates the signal through space.

(i) Describe **TWO (2)** advantages and **TWO (2)** disadvantages of wireless communication.

[4 marks]

(ii) Discuss **TWO (2)** ways how the coverage area of a cellular cell can be controlled.

[4 marks]

(b) For both the deployment of a wireless cellular system in the scenarios in Figure Q1.1(a) and Figure Q1.1(b) , the cluster size, N is 4, and the area size is 10km^2.

Justify which configuration for deployement should be selected if the requirement for the system is high capacity. Discuss also the tradeoff or drawbacks in the design of your selection.

[3+2 marks]

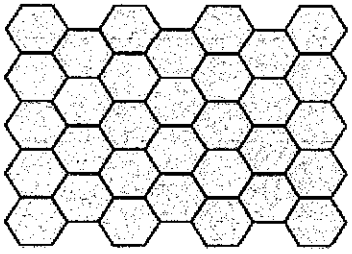

Figure Q1.1(a): Cell radius = 1.6 km, $N = 4$, area size 10km^2

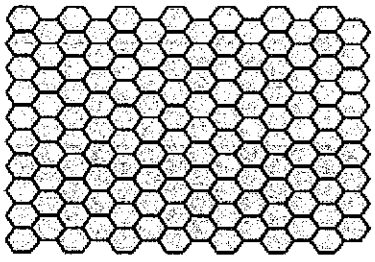

Figure Q1.1(b): Cell radius = 0.8 km, $N = 4$, area size 10km^2

Continued.....

Question 1 (cont.)

(c)

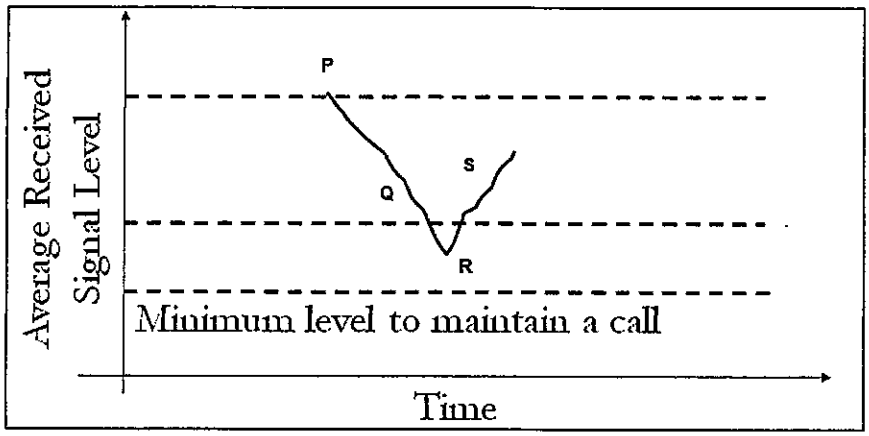

Figure Q1.2

Figure Q1.2.shows the average Received Signal Stregth (RSS) of a User Terminal (UT) during a procedure in wireless communication.

Describe the procedure with reference to the RSS changes of the UT in points P,Q,R and S as shown in **Figure Q1.2**.

[8 marks]

(d) Describe TWO challenges in the implementation of Internet-of-Things (IoT) systems.

[4 marks]

Question 2

(a) Fading is caused by interference between two or more versions of the transmitted signal which arrive at the receiver at slightly different times.

(i) Describe THREE small scale fading effects.

[6 marks]

(ii) Discuss TWO factors that influence small scale fading.

[4 marks]

Continued.....

(b) The multipath profile of a channel is given in **Figure Q2.1**. Justify if this channel is suitable for Global System for Mobile (GSM) service without the use of an equalizer if the minimum bandwidth for GSM channel is 200kHz?

[10 marks]

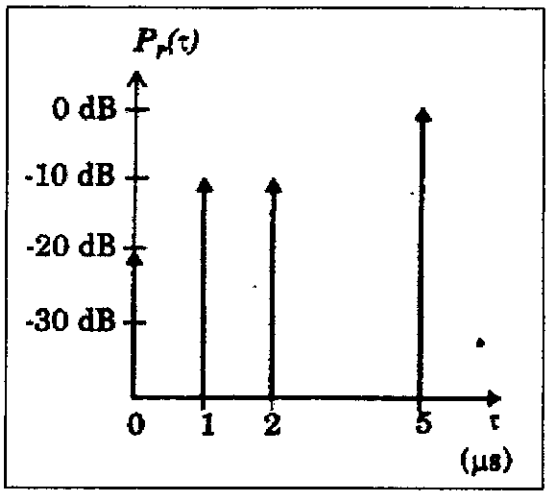

Figure Q2.1

(c) **Figure Q2.2 (a)** and **Figure Q2.2 (b)** show two components in a radio system. Ientify the components and describe briefly their functions.

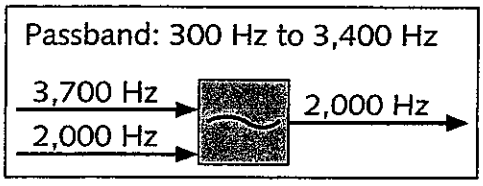

Figure Q2.2 (a)

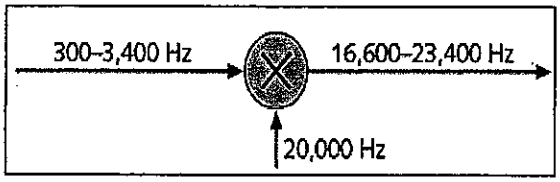

Figure Q2.2 (b)

[5 marks]

Continued.....

Question 3

(a) Give **THREE (3)** examples of current and future applications for Wireless Personal Area Network (WPAN) technology with low data rates:

[6 marks]

(b) Once a Bluetooth device is connected to a piconet, what are the four power modes that the device is able to implement.

[8 marks]

(c) Given that you have five ZigBee devices. Design the **THREE (3)** basic topologies for ZigBee networks that you can create based on the five devices. Include sketches in your design.

[6 marks]

(d) In addition to a mobile device and an Internet service provider, only wireless network interface cards (WNICs) and access points (APs) are needed for communications to take place. Explain WNICs and APS.

[5 marks]

Question 4

(a) Discuss the advantages of IEEE802.11ac over the previous versions of IEEE802.11 standards.

[5 marks]

(b) What are differences between Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA) and WPA2?

[6 marks]

(c) List the frequency ranges and their common applications for Radio Frequency Identification (RFID).

[8 marks]

Continued.....

(d) A reader illuminates a 1-m diameter disk that is 2 m away (Figure Q4.1). A tag is placed behind the disk at (i) 5 cm and (ii) 2 m. Determine which Fresnel zone the edge of the disk lies at 915 MHz and comment on the impact of the tag receiving the reader signal.

[6 marks]

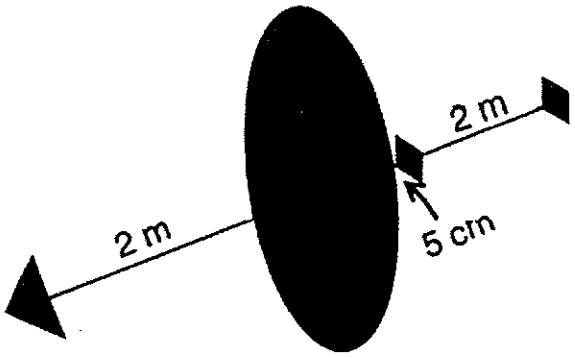

Figure Q4.1

Continued...

Appendix I: Constant values

Speed of light, c = 3×10^8 m/s

Antenna

Effective isotropic radiated power, $EIRP = P_t G_t$

Power flux density, $\phi = \dfrac{EIRP}{4\pi R^2}$

Received power, $P_r = \phi A_{eff}$

Antenna gain of a circular aperture or reflector of diameter D:

$$G_{\max} = \left(\frac{4\pi}{\lambda^2}\right)A_{eff} = \eta\left(\frac{\pi D}{\lambda}\right)^2 = \eta\left(\frac{70\pi}{\theta_{3dB}}\right)^2, \text{ where } \theta_{3dB} = 70\left(\frac{\lambda}{D}\right)$$

Link Analysis

Received power, $[P_r] = [EIRP] + [G_r] - [L_{Total}]$

Free space loss,

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$$

$$PL(\text{dB}) = 10\log\left(\frac{P_t}{P_r}\right) = -10\log\left(\frac{\lambda^2}{(4\pi)^2 d^2}\right)$$

$$P_r(d)\,\text{dBm} = 10\log\left[\frac{P_r(d_0)}{0.001\,\text{W}}\right] + 20\log\left(\frac{d_0}{d}\right) \qquad d \ge d_0 \ge d_f$$

Log-Distance Path Loss

$$\overline{PL}(\text{dB}) = \overline{PL}(d_0) + 10\,n\log\left(\frac{d}{d_0}\right)$$

Doppler shift,

$$f_d = \frac{v}{\lambda}\cos\theta$$

Noise power spectral density, $N_o = kT$

Time Dispersion Parameters

RMS delay spread,

$$\sigma_\tau = \sqrt{\overline{\tau^2} - (\overline{\tau})^2}$$

where

$$\overline{\tau^2} = \frac{\sum_k a_k^2 \tau_k^2}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k^2}{\sum_k P(\tau_k)}$$

Mean excess delay,

$$\bar{\tau} = \frac{\sum_k a_k^2 \tau_k}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k}{\sum_k P(\tau_k)}$$

End of Paper